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Specification

1. Title of the Invention

DISPLAY DEVICE

2. Claim

(1) An active matrix type display device, in which thin film transistors having a semiconductor layer are disposed in a matrix corresponding to the respective segment electrodes formed of a plurality of light transmitting conductive oxide films disposed in a matrix, the source electrodes of the thin film transistors are partly superposed to be connected to the segment electrodes corresponding to the transistors, and the drain electrodes of a designated number of thin film transistors are integrally extended and connected, characterized in that the source electrodes and drain electrodes of the transistors have a two-layer structure including a base layer formed of high melting point metal such as titanium, the superposition part of the source electrode and the segment electrode is formed of a layered product of the light transmitting conductive oxide, the high melting point metal and electrode main metal, and the connecting part of the semiconductor layer and the source electrode and the drain electrode of the transistor is formed of a layered product of a semiconductor, the high concentration impurity semiconductor, the high melting point metal and the electrode main metal.

3. Detailed Description of the Invention

(i) Industrial Field of Application

This invention relates to a display device such as a liquid crystal display device having a matrix-like display segment.

(ii) Prior Art

As the display device having a matrix type display segment, there are various types of display devices such as the device using a liquid crystal display as disclosed in "FLAT PANEL DISPLAY AIMING AT DOCUMENT AND IMAGE DISPLAY" of NIKKEI ELECTRONICS dated January 2, 1984 and the device using an electroluminescence display. At present the future of the liquid crystal display is highly evaluated in that the power consumption can be lowered and large capacity can be attained.

Fig. 3 (a) shows a plan view of the principal part of general configuration of this type of liquid crystal display device, and Fig. 3 (b) shows a section taken along line X - X thereof. In the drawings, the reference numeral 10 designates a first glass substrate, and 11 designates segment electrodes formed of transparent ITO and arranged in a matrix (about 250 × 600) on the first glass substrate 10 through a layer insulation film 12 formed of silicon nitride. The reference numeral 13 designates a plurality of amorphous silicon film lines arranged parallel in the longitudinal direction on the layer insulation film 12 in the gaps between the segment electrodes 11, 11 and projected semiconductor operating regions 14, 14 are provided in the lower left corner spaces of the respective segment electrodes 11, 11. The reference numeral 15 designates drain lines formed of an aluminum film and disposed on each amorphous silicon film line 13 where drain

electrodes 16, 16 superposed on the left sides of the respective semiconductor operating regions 14, 14 are projected. The reference numeral 17 designates source electrodes formed of an aluminum film and partly superposed on the right sides of the respective semiconductor operating regions 14, 14, and the right sides thereof are connected to the left lower end parts of the respectively corresponding segment electrodes 11, 11 on the layer insulation film 12. The reference numeral 18 designates a plurality of gate lines disposed parallel in the lateral direction in the gap positions of the segment electrodes 11, 11 and formed of a two-layer film of gold and chrome formed in a layer between the first substrate 10 and the insulation film 12, and on the lines 18, a gate electrode 19 under the semiconductor operating region 14 in the gap position between the source electrode 17 and the drain electrode 16 is integrally projected. That is, thin film transistors TFT are disposed in a matrix by the drain electrode 16 designated by the reference sign D in the drawing, the source electrode 17 designated by S, the gate electrode 19 designated by G and the semiconductor operating region 14 connected to the electrodes D, S, G and formed of an amorphous silicon film, and the respective segments 11, 11 are respectively connected to the drain line 15 through the corresponding TFT. The reference numeral 100 designates an alignment layer covering all over the respective segment electrodes 11, 11, the drain line 15 and the TFT part.

On the other hand, the reference numeral 20 designates a second glass substrate, and on the lower surface, that is, on the surface opposite to the first glass substrate 10, a common electrode 21 and

an alignment layer 200 are sequentially formed on the whole surface.

The reference numeral 30 designates liquid crystal substance enclosed between both substrates 10, 20, that is, between both alignment layers 100, 200, and the TFT turns on at every matrix segment, whereby a display signal, that is, the liquid crystal substance 30 at the segment electrode 11 part of the first glass substrate 10 to which the liquid crystal excitation voltage is applied causes an electrooptic effect.

(iii) Problems that the Invention is to Solve

The conventional display device described above has the disadvantage that since the aluminum of the source electrode 17 directly comes into contact with the upper side of the ITO of the segment electrode 11 in the TFT as shown in the sectional view of the principal part of Fig. 2, in forming the source electrode, a patterning phosphoric acid-base etchant for aluminum causes electrochemical reaction between the ITO and aluminum, resulting in erosion of the contact part between the ITO and the aluminum so that contact failure is caused between the source electrode 17 and the segment electrode 11.

Further, the disadvantage is that since the aluminum of the source electrode 17 and the drain electrode 16 comes into contact with the upper side of the semiconductor operation region 14 of amorphous silicon through n^+ type amorphous silicon film 14' for making ohmic contact therewith, the aluminum is diffused and introduced in the n^+ type amorphous silicon film 14' by subsequently curing polyimide (200°C, one hour) of the alignment layer 100, resulting in lowering the concentration of n^+ of the n^+ type amorphous silicon film 14' to inhibit the function of the ohmic contact of the film 14'.

(iv) Means for Solving the Problems

This invention provides a display device in which a source electrode and a drain electrode of a TFT have a two-layer structure including high melting point metal such as titanium in a base layer, and high melting point metal is coexistent between the electrode main metal and a light transmitting conductive oxide and between the electrode main metal and a high impurity amorphous semiconductor layer of the surface part of the amorphous semiconductor layer.

(v) Operation

In the display device of the invention, in a superposition part of the source electrode and the segment electrode, intermediate high melting point metal such as titanium is interposed between aluminum and ITO, whereby even in a development liquid and phosphoric acid-base etchant, no electrochemical reaction is caused both in contact between aluminum and titanium and in contact between titanium and ITO.

Furthermore, the presence of this high melting point metal such as titanium can prevent the metal material such as aluminum of these electrodes from being diffused in the semiconductor layer at the connecting parts of the source electrode and the drain electrode to the high concentration impurity amorphous semiconductor layer.

Further, the drain electrode serving as wiring in the display device is provided with the base layer of high melting point metal, whereby trouble of disconnection in wiring of the drain electrode can be eliminated.

(vi) Embodiment

Fig. 1 shows a sectional view of the principal part of a display

device according to the invention. The device shown in the drawing is so constructed that a gate electrode 19 formed of a two-layer film of gold and chrome, an insulation film 12 formed of silicon nitride, and a semiconductor operation region 14 formed of intrinsic amorphous silicon film are sequentially formed on a glass substrate 10, further phosphor doped n^+ type amorphous silicon films 14', 14' are continuously formed on the drain and source regions on the region 14, and further a segment electrode 11 formed of ITO is formed adjacent thereto. The above is formed similarly to the conventional device of Fig. 2.

The display device of the invention differs from the conventional device of Fig. 2 in that the drain electrode 16 and the source electrode 17 formed on the above n^+ type amorphous silicon film 14', 14'and ITO of the segment electrode 11 are respectively provided with base layers 16', 17' formed of titanium which is high melting point metal. The base layer 16' is extended in common under the drain line 15 of Fig. 3 connected to the drain electrode 16.

Accordingly, even in the case where phosphoric acid-base etchant is used for patterning the aluminum which becomes the drain electrode 16 connected to the drain line 15 and the source electrode 17, titanium is interposed between the aluminum and ITO, whereby electrochemical reaction is not caused both in contact between aluminum and titanium and in contact between titanium and ITO. Thus, ohmic contact can be secured among the three layers of the segment electrode 11 of ITO, the base layer 17' of titanium and the source electrode 17.

On the other hand, even in the case of performing curing (200 °C, one hour) in forming an alignment layer 100 formed of polyimide

similar to that of Fig. 3 on the above segment electrode 11 and the TFT, the aluminum of the drain electrode 16 and the source electrode 17 is prevented from being diffused and introducing in the lower n^+ type amorphous silicon film 14', 14' by the presence of titanium of the base layers 16', 17'.

Further, since the base layer is present under the aluminum film of the drain line 15 as well, even if disconnection is caused in either of both upper and lower layers, both layers may mutually compensate for it to keep the electric connection.

Although amorphous silicon is used as the semiconductor layer of the TFT in the above embodiment, this is not restrictive, but general non-single crystalline semiconductor layers of polycrystalline material such as selenium may be used, and as the segment electrode 11, in addition to ITO, light transmitting conductive oxide can be used. Further, as the base layers 16', 17', in addition to titanium, high melting point metal such as molybdenum, tungsten or tantalum can be used, and in addition to aluminum, metal such as chrome can be used in the drain electrode 16 and the source electrode 17.

(vii) Advantage of the Invention

It will be apparent from the above description that according to the invention, the display device is constructed as a two-layer structure by providing the source electrode and the drain electrode of the TFT with the base layer formed of high melting point metal, thereby preventing disconnection of the drain electrode and the source electrode itself, besides preventing contact failure between the source electrode and the segment electrode formed of light transmitting

conductive oxide, and also inhibiting diffusion and introduction of electrode material from the drain electrode and the source electrode to the high impurity semiconductor on the semiconductor layer.

Accordingly, ohmic contact can be kept between the semiconductor of the TFT and the respective electrodes and between the source electrode and the segment electrode, thereby remarkably improving the reliability of this type of active matrix type display device.

4. Brief Description of the Drawings

Fig. 1 is a sectional view of the principal part of a display device according to the invention;

Fig. 2 is a sectional view of the principal part of a conventional device; and

Figs. 3 (a) and 3 (b) are respectively a plan view of the conventional device and a sectional view taken along line X - X of the device.

10, 20: substrate 11: segment electrode 12: layer insulation film 13: amorphous silicon film line 14: semiconductor operating region 14': n^+ type amorphous silicon film 15: drain line 16: drain electrode 16': base layer 17: source electrode 17': base layer 18: gate line 19: gate electrode 21: common electrode 30: liquid crystal substance